

Lecture Notes in Mathematics

Edited by A. Dold and B. Eckmann

1340

S. Hildebrandt D. Kinderlehrer
M. Miranda (Eds.)

Calculus of Variations and Partial Differential Equations

Proceedings of a Conference held in Trento, Italy
June 16–21, 1986



Springer-Verlag

Berlin Heidelberg New York London Paris Tokyo

Editors

Stefan Hildebrandt
Mathematisches Institut, Universität Bonn
Wegelerstr. 10, 5300 Bonn, Federal Republic of Germany

David Kinderlehrer
School of Mathematics, University of Minnesota
206 Church St. SE, Minneapolis, MN 55455, USA

Mario Miranda
Centro Internazionale per la Ricerca Matematica
38050 Povo-Trento, Italy

Mathematics Subject Classification (1980): 35A15, 35G20, 35J20, 35J25,
35J65, 35Q10

ISBN 3-540-50119-3 Springer-Verlag Berlin Heidelberg New York
ISBN 0-387-50119-3 Springer-Verlag New York Berlin Heidelberg

Library of Congress Cataloging-in-Publication Data.

Calculus of variations and partial differential equations: proceedings of a conference, held in Trento, Italy, June 16–21, 1986 / S. Hildebrandt, D. Kinderlehrer, M. Miranda, eds. p.cm. — (Lecture notes in mathematics; 1340) Includes bibliographies.

ISBN 0-387-50119-3 (U.S.)

1. Calculus of variations — Congresses. 2. Differential equations, Partial — Congresses.
I. Hildebrandt, Stefan. II. Kinderlehrer, David. III. Miranda, Mario, 1937—. IV. Series: Lecture notes in mathematics (Springer-Verlag); 1340.

QA3.L28 no. 1340 [QA315] 510 s—dc 19 [515'.64] 88-20180

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in other ways, and storage in data banks. Duplication of this publication or parts thereof is only permitted under the provisions of the German Copyright Law of September 9, 1965, in its version of June 24, 1985, and a copyright fee must always be paid. Violations fall under the prosecution act of the German Copyright Law.

© Springer-Verlag Berlin Heidelberg 1988
Printed in Germany

Printing and binding: Druckhaus Beltz, Hemsbach/Bergstr.
2146/3140-543210

PREFACE

A delight and a privilege is before us: we have gathered from many nations and across many generations to dedicate this conference and its proceedings to Hans Lewy. The scientific achievements of Professor Lewy are well established. None of us cease to be influenced by the depth and imagination of his scientific vision, by what we may correctly refer to as his genius. Equally important, we have continued to receive our own inspiration from *il suo gusto ed il suo garbo* - his taste and his style - in his choice of scientific issues and their resolution. His constant dedication to the encouragement of young mathematicians stands before us as a model. We are grateful for this opportunity to demonstrate our esteem and appreciation of Hans Lewy, the man and the scientist.

Stefan Hildebrandt

David Kinderlehrer

Mario Miranda

Conference Committee

ACKNOWLEDGEMENTS

We wish to thank all the participants for their contribution to the success of the meeting.

We express our gratitude to the Comitato Nazionale per le Scienze Matematiche of the Consiglio Nazionale delle Ricerche and to the Centro Internazionale per la Ricerca Matematica of the Istituto Trentino di Cultura for their invaluable support.

Special thanks are due to Augusto Micheletti for his help in running the conference, and for his wonderful job in the typing of all the manuscripts.

Stefan Hildebrandt

David Kinderlehrer

Mario Miranda

Conference Committee

LIST OF PARTICIPANTS

- Hans Lewy (Berkeley, California, USA)
- Emilio Acerbi (Scuola Normale Superiore, Pisa, Italy)
- Giovanni Alessandrini (Istituto di Matematica, Università Firenze, Italy)
- Luigi Ambrosio (Scuola Normale Superiore, Pisa, Italy)
- Gabriele Anzellotti (Dipartimento di Matematica, Univ. Trento, Povo, Italy)
- Alberto Arosio (Dipartimento di Matematica, Univ. Parma, Italy)
- Abbas Bahri (Departement de Mathématiques, Ecole Polytechnique Palaiseau, France)
- Claudio Baiocchi (Dipartimento di Matematica, Univ. Pavia, Italy)
- Michele Balzano (S.I.S.S.A., Trieste, Italy)
- Martino Bardi (Seminario Matematico, Univ. Padova, Italy)
- Giovanni Bassanelli (Dipartimento di Matematica, Univ. Trento, Povo, Italy)
- Hugo Beirão da Veiga (Dipartimento di Matematica, Univ. Trento, Povo, Italy)
- Enrico Bernardi (Dipartimento di Matematica, Univ. Bologna, Italy)
- Antonio Bove (Dipartimento di Matematica, Univ. Bologna, Italy)
- Haim Brezis (Analyse Numérique, Univ. Pierre et Marie Curie, Paris, France)
- Giuseppe Buttazzo (Scuola Normale Superiore, Pisa, Italy)
- Elio Cabib (Istituto di Meccanica Teorica e Applicata, Univ. Udine, Italy)
- Michele Carriero (Dipartimento di Matematica, Univ. Lecce, Italy)
- Filippo Chiarenza (Dipartimento di Matematica, Univ. Catania, Italy)
- Maurizio Chicco (Istituto di Matematica, Univ. Genova, Italy)
- Franco Conti (Scuola Normale Superiore, Pisa, Italy)
- Gianni Dal Maso (S.I.S.S.A., Trieste, Italy)
- Anneliese Defranceschi (S.I.S.S.A., Trieste, Italy)
- Ennio De Giorgi (Scuola Normale Superiore, Pisa, Italy)
- Michele Emmer (Dipartimento di Matematica, Univ. Roma I, Italy)
- Robert Finn (Department of Mathematics, Stanford Univ., California, USA)

- Hisao Fujita-Yashima (Scuola Normale Superiore, Pisa, Italy)
- Paul R. Garabedian (Courant Institute, New York Univ., USA)
- Nicola Garofalo (Dipartimento di Matematica, Univ. Bologna, Italy)
- Maria Giovanna Garroni (Dipartimento di Matematica, Univ. Roma I, Italy)
- Fabio Gastaldi (Istituto di Analisi Numerica, Pavia, Italy)
- Andrea Gavioli (Dipartimento di Matematica, Univ. Modena, Italy)
- Mariano Giaquinta (Istituto di Matematica Applicata, Univ. Firenze, Italy)
- Enrico Giusti (Istituto di Matematica, Univ. Firenze, Italy)
- Robert Gulliver (School of Mathematics, Univ. of Minnesota, Minneapolis, USA)
- Erhard Heinz (Mathematisches Institut, Univ. Göttingen, Fed. Rep. of Germany)
- Mimmo Iannelli (Dipartimento di Matematica, Univ. Trento, Povo, Italy)
- Fritz John (Courant Institute, New York Univ., USA)
- Ermanno Lanconelli (Dipartimento di Matematica, Univ. Bologna, Italy)
- Peter Laurence (Mathematics Department, Pennsylvania State University, University Park, USA)
- Antonio Leaci (Dipartimento di Matematica, Univ. Lecce, Italy)
- Francesco Leonetti (Dipartimento di Matematica, Univ. L'Aquila, Italy)
- Marco Longinetti (I.A.G.A., Firenze, Italy)
- Enrico Magenes (Dipartimento di Matematica, Univ. Pavia, Italy)
- Giovanni Mancini (Dipartimento di Matematica, Univ. Trieste, Italy)
- Pierangelo Marcati (Dipartimento di Matematica, Univ. L'Aquila, Italy)
- Silvana Marchi (Dipartimento di Matematica, Univ. Parma, Italy)
- Elvira Mascolo (Istituto di Matematica, Univ. Salerno, Italy)
- Umberto Massari (Dipartimento di Matematica, Univ. Ferrara)
- Albert Milani (Dipartimento di Matematica, Univ. Torino, Italy)
- Enzo Mitidieri (Dipartimento di Matematica, Univ. Trieste, Italy)
- Giuseppe Modica (Istituto di Matematica Applicata, Univ. Firenze, Italy)
- Stefano Mortola (Dipartimento di Matematica, Univ. Pisa, Italy)
- Umberto Mosco (Dipartimento di Matematica, Univ. Roma I, Italy)
- Venkatesha Murthy (Dipartimento di Matematica, Univ. Pisa, Italy)
- Roberta Musina (S.I.S.S.A., Trieste, Italy)

- Wei Ming Ni (School of Mathematics, Univ. of Minnesota, Minneapolis, USA)
- Louis Nirenberg (Courant Institute, New York Univ., USA)
- Tullia Norando (Dipartimento di Matematica, Politecnico Milano, Italy)
- Pirro Oprezzi (Istituto Matematico, Univ. Genova, Italy)
- Gabriella Paderni (S.I.S.S.A., Trieste, Italy)
- Luigi Pepe (Dipartimento di Matematica, Univ. Ferrara, Italy)
- Carlo Pucci (Istituto di Matematica, Univ. Firenze, Italy)
- Andrea Pugliese (Dipartimento di Matematica, Univ. Trento, Povo, Italy)
- Marco Sabatini (Dipartimento di Matematica, Univ. L'Aquila, Italy)
- Sandro Salsa (Dipartimento di Matematica, Univ. Milano, Italy)
- Donato Scolozzi (Dipartimento di Matematica, Univ. Pisa, Italy)
- Paolo Secchi (Dipartimento di Matematica, Univ. Trento, Povo, Italy)
- Raul Serapioni (Dipartimento di Matematica, Univ. Trento, Povo, Italy)
- James Serrin (School of Mathematics, Univ. of Minnesota, Minneapolis, USA)
- Dan Socolescu (Institut für Angew. Mathematik, Univ. Karlsruhe, Fed. Rep. of Germany)
- Joel Spruck (Department of Mathematics, Univ. Massachusetts, Amherst, USA)
- Italo Tamanini (Dipartimento di Matematica, Univ. Trento, Povo, Italy)
- Ermanna Tomaini (Dipartimento di Matematica, Univ. Ferrara, Italy)
- Franco Tomarelli (Dipartimento di Matematica, Univ. Pavia, Italy)
- Mario Tosques (Dipartimento di Matematica, Univ. Pisa, Italy)
- Luciano Tubaro (Dipartimento di Matematica, Univ. Trento, Povo, Italy)
- Alberto Valli (Dipartimento di Matematica, Univ. Trento, Povo, Italy)
- Giorgio Vergara Caffarelli (Dipartimento di Matematica, Univ. Pisa, Italy)
- Epifanio Virga (Dipartimento di Matematica, Univ. Pisa, Italy)
- Maria Antonia Vivaldi (Dipartimento di Matematica, Univ. Roma I, Italy)
- Anna Zaretti (Dipartimento di Matematica, Politecnico Milano, Italy)

and the Conference Committee:

- Stefan Hildebrandt (Mathematisches Institut, Univ. Bonn, Fed. Rep. of Germany)
- David Kinderlehrer (School of Mathematics, Univ. of Minnesota, Minneapolis, USA)
- Mario Miranda (Dipartimento di Matematica, Univ. Trento, Povo, Italy)

CONTENTS

A. Arosio – <i>Global solvability of second order evolution equations in Banach scales</i>	1
H. Beirão da Veiga – <i>On the incompressible limit of the compressible Navier-Stokes equations</i>	11
E. Bernardi, A. Bove, C. Parenti – <i>On a class of hyperbolic operators with double characteristics</i>	23
G. Buttazzo – <i>Relaxation problems in control theory</i>	31
R. Finn – <i>The inclination of an H-graph</i>	40
P.R. Garabedian – <i>On the mathematical theory of vortex sheets</i>	61
N. Garofalo – <i>New estimates of the fundamental solution and Wiener's criterion for parabolic equations with variable coefficients</i>	70
M.G. Garroni – <i>Green function and invariant density for an integro-differential operator</i>	84
M. Giaquinta – <i>Some remarks on the regularity of minimizers</i>	95
E. Giusti – <i>Quadratic functionals with splitting coefficients</i>	104
R. Gulliver – <i>Minimal surfaces of finite index in manifolds of positive scalar curvature</i>	115
R. Hardt, D. Kinderlehrer, M. Luskin – <i>Remarks about the mathematical theory of liquid crystals</i>	123
E. Heinz – <i>On quasi-minimal surfaces</i>	139
P. Laurence, E. Stredulinsky – <i>A survey of recent regularity for second order queer differential equations</i>	146
C.-S. Lin, W.-M. Ni – <i>On the diffusion coefficient of a semilinear Neumann problem</i>	160
M. Longinetti – <i>Some isoperimetric inequalities for the level curves of capacity and Green's functions on convex plane domains</i>	175
P. Marcati – <i>Nonhomogeneous quasilinear hyperbolic systems: initial and boundary value problem</i>	193
E. Mascolo – <i>Existence results for non convex problems of the calculus of variations</i>	201
U. Mosco – <i>Wiener criteria and variational convergences</i>	208
L. Nirenberg – <i>Fully nonlinear second order elliptic equations</i>	239
J. Serrin – <i>Positive solutions of a prescribed mean curvature problem</i>	248
D. Socolescu – <i>On the convergence at infinity of solutions with finite Dirichlet integral to the exterior Dirichlet problem for the steady plane Navier-Stokes system of equations</i>	256
J. Spruck – <i>The elliptic Sinh-Gordon equation and the construction of toroidal soap bubbles</i>	275